

REMARKS/ARGUMENTS

Claims 1-9 and 28 are pending herein. Claim 1 has been amended as supported by, for example, paragraph [0019] of the original specification. Claim 27 has been cancelled without prejudice or disclaimer.

1. The rejection of claim 27 under §112, second paragraph is noted, but deemed moot in view of the cancellation of that claim.

2. Claims 1-9, 27 and 28 were rejected under §103(a) over Imaeda et al. (JP 10-265293; assigned to the same assignee as that of the present application) in view of Shudo et al. or Ciszek et al. To the extent that these rejections might be applied against the amended claims, they are respectfully traversed.

With reference to Fig. 1 of the present application, for example, pending independent claim 1 recites a process for producing an oxide single crystal, in which the oxide single crystal is grown from a raw material melt that is drawn through an opening 13c of crucible 7. A cooling mechanism 14 directly cools the oxide single crystal while the crystal is being drawn from the opening of the crucible. While a portion of a first heater 4 is provided around the opening of the crucible, a second heater 15 is provided around the oxide single crystal downstream from the cooling mechanism. Pending claim 1 has been amended to clarify that a temperature gradient within a distance of 1 mm from the opening 13c of the crucible is 100°C/mm or more. The applied prior art references, discussed below, do not disclose or suggest the temperature gradient within a distance of 1 mm from the opening of the crucible limitation recited in pending independent claim 1.

Applicants discovered that a specific temperature gradient (i.e., at least 100°C/mm) within 1 mm from the crucible opening 13c allows for the production of oxide single crystals having desired crystal planar body and shoulder portion lengths, while substantially

suppressing the formation of cracks in the grown crystals (see original specification, Example 1, paragraphs [0040]-[0042]). Example 1 of the present application illustrates the process by which an oxide single crystal is grown using the single crystal-producing apparatus shown in Fig. 1. The raw material in the crucible is melted while controlling the temperature in space 5 near upper furnace unit 1 to be within a range of 1100-1200°C. While the temperature in anneal region 20 near lower furnace unit 3 is controlled uniformly at 700°C, the temperature in single-crystal growing portion 35 is controlled to be about 1000°C. A temperature gradient within a distance of 1 mm from opening 13c of the crucible is controlled to be greater than 100°C/mm (see original specification, paragraph [0038]). Example 1 shows that the oxide single crystal planar body and shoulder portions were grown to a length of 100 mm, while no cracking in the crystal was observed during growing and annealing the crystal (see original specification, paragraph [0042]).

Comparative Example 2 of the present application shows that an inferior oxide single crystal results when the temperature gradient is not controlled to be at least 100°C/mm within 1 mm from the crucible opening. The only difference between the processing conditions disclosed in Comparative Example 2 and those in Example 1, discussed above, is that the temperature gradient is not controlled in a region immediately below the crucible opening. As is shown in original specification paragraph [0047] on page 12 of the specification, when a temperature gradient within a distance of 1 mm from the crucible opening is less than 100°C/mm, as in the case of Comparative Example 2, the width of the single crystal is prone to fluctuation and does not increase beyond 20 mm, and many striations are found in the grown crystal body.

Similar to Comparative Example 2 discussed immediately above, JP '293 does not employ a cooling mechanism that directly cools the oxide single crystal while the crystal is

being drawn from the crucible opening, and therefore, does not even remotely recognize that any benefits, let alone the above-discussed benefits, would arise from controlling the temperature gradient to be at least 100°C/mm within 1 mm from the crucible opening, as claimed. Nor do Ciszek or Shudo recognize any benefits associated with controlling the temperature gradient immediately below the crucible opening, as claimed.

Ciszek and Shudo disclose only methods of growing *silicon* crystals. As such, generic disclosure pertaining only to cooling the *silicon* crystal solid-liquid crystal interface using a cooling mechanism does not fairly disclose or suggest a specific temperature gradient with respect to any portion of the crucible for use in forming *oxide single crystals*. There is especially no disclosure or suggestion in either of Ciszek or Shudo that any benefits would be gained from ***controlling the temperature gradient within 1 mm of the crucible opening to be at least 100 °C/mm, as claimed***. Again, as evidenced by Example 1 of the present application, Applicants discovered that a specific temperature gradient (i.e., at least 100°C/mm) within 1 mm from the crucible opening results in oxide single crystals having desired, beneficial crystal planar body and shoulder portion parameters, while, at the same time, substantially suppressing the formation of cracks in the grown crystals.

In view of all of the foregoing, reconsideration and withdrawal of the §103(a) rejection over JP 10-265293 in view of Shudo et al. or Ciszek et al. are respectfully requested.

3. Claims 1-9, 27 and 28 were rejected under §103(a) over Mimura in view of Shudo. To the extent that this rejection might be applied against the amended claims, it is respectfully traversed.

Mimura discloses controlling the temperature in the vicinity of the solid-liquid interface where the crystal is grown by using a heater, which enables the provision of a thermal gradient in the neighborhood of the solid-liquid interface (see col. 4, lines 41-48). As

discussed above, Shudo discloses only that a *silicon* crystal solid-liquid crystal interface can be cooled using a cooling mechanism. Pending claim 1, on the other hand, now recites that a temperature gradient within a distance of 1 mm from the crucible opening is 100°C/mm or more. Mimura's disclosure that the temperature in the vicinity or neighborhood of the solid-liquid crystal interface proves that Mimura does not recognize that any benefits would be gained from controlling the temperature gradient within 1 mm of the crucible opening to be at least 100°C/mm, as claimed. Shudo's generic disclosure pertaining only to cooling the *silicon* crystal solid-liquid crystal interface using a cooling mechanism does not fairly disclose or suggest a specific temperature gradient for use in forming *oxide single crystals*, let alone a specific temperature gradient within 1 mm of the crucible opening.

It is clear, therefore, that even if Mimura and Shudo were combined as asserted in the Office Action, that combination would still not disclose or suggest each and every feature of pending claim 1. Again, as evidenced by a comparison between Example 1 and Comparative Example 2 of the present application, Applicants discovered that a specific temperature gradient (i.e., at least 100°C/mm) within 1 mm from the crucible opening results in oxide single crystals having desired, beneficial crystal planar body and shoulder portion parameters, while substantially suppressing the formation of cracks in the grown crystals.

In view of the foregoing, reconsideration and withdrawal of the §103(a) rejection over Mimura in view of Shudo are respectfully requested.

4. Claims 1-9, 27 and 28 were rejected under the judicially created doctrine of obviousness-type double patenting over claims 1, 13, 22 and 26 of U.S. Patent No. 6,565,654 in view of Shudo. the PTO is requested to hold this rejection in abeyance until the above-discussed art-based rejections of record have been overcome, at which time Applicants will consider filing a Terminal Disclaimer to overcome this rejection.

If the Examiner believes that contact with Applicants' attorney would be advantageous toward the disposition of this case, the Examiner is herein requested to call Applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

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Date

Respectfully submitted,



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